POST-TEST BLASTING REPORT
1150 BENCH BLASTING FOR COFFERDAM/EXCAVATION

JUVENILE FISH PASSAGE FACILITY
ADDITIONAL WATER STORAGE PROJECT

HOWARD A. HANSON DAM
WASHINGTON

4 October 2004

1 EXECUTIVE SUMMARY

Blasting was conducted in May 2004 of the rock mass south of the existing outlet tower and outlet tower bridge. The blasting was conducted to excavate rock related to construction of the Juvenile Fish Passage Facility (JFPF). A series of 10 production blasts were conducted along the southern margin of the excavation to an elevation of 1150 feet. This series of production blasts was used by the Corps as an opportunity to test the response of critical structures protection instrumentation and related safety procedures before blasting adjacent to the tower, which is scheduled to begin in September 2004.

Blasting procedures as outlined in the contractor's blasting plans were followed. Existing Structures Protection Plan (USACE, 2004) procedures were also followed and found to be adequate. Most instrumentation performed as designed. Instruments not performing as designed were repaired/ replaced.

It is recommended that the contractor be allowed to proceed with blasting in September 2004.

2 INTRODUCTION

Construction of the Juvenile Fish Passage Facility (JFPF) requires excavation of approximately 50,000 cubic yards of rock adjacent to the existing outlet tower, outlet tower bridge and outlet tunnel. These existing structures are critical for the operation of the project. Blasting is the most cost effective method to remove the rock and create the excavation where the JFPF will be constructed. To mitigate the potential hazards of the rock excavation, prescribed controlled blasting techniques were specified, rigorous experience criteria were specified for the blaster and the blasting consultant, instrumentation was installed on all potentially affected critical structures, threshold and limiting criteria were developed for all instruments, and a plan was developed to define roles and responsibilities and procedures for protecting the existing structures during JFPF construction (USACE, 2004).

A series of 10 blasts, plus one event that included blasting of boulders only and one clean-up blast to set off an unexploded trim hole, were performed by Traylor Brothers and their sub-contractors to excavate rock south of the existing outlet tower and bridge (Figure 1). The blasts were used to excavate rock to establish a working bench at elevation 1150 feet to be used by the contractor for further construction activities. The blasts were far from existing critical structures relative to future blasts, which will be much closer to existing adjacent structures. The blasts were deliberately designed by the blaster to test the effect of controlled blasting techniques while maximizing blasting productivity. USACE treated this series of blasts as test blasts to evaluated the existing structures protection plan procedures, test instrumentation response values versus predictions, develop site specific rock response value constants for predicting future blasting effects on nearby structures, evaluate the need for more instruments, and test the functionality of the existing structures protection instruments and data reduction and transmittal system.

3 BLASTING PROCEDURES

Blasting was conducted using controlled blasting procedures to meet the following objectives:

- Control flyrock.
- Limit blast induced vibrations on the existing structures.
- Minimize misfires, premature detonations and sympathetic detonations.
- Minimize explosives residue and leakage into reservoir.
- Minimize overbreak on final excavation faces.

Blast mats composed of rubber from truck tires were placed over the surface and open faces of each blast to eliminate flyrock. The maximum charge per delay for each blast was designed to minimize blast induced vibrations by using standard empirical scaled relationships to predict the potential vibrations from each blast. Also, blasting was conducted with a free face to minimize excessive vibration caused by confined blasting. Misfires were prevented by carefully hooking up the shock tube initiation system and performing an independent inspection of the setup before each blast. One misfire occurred in a trim hole during the last blast. The likely cause of this misfire was severing of the shock tube during placement of the blast mats. The blaster will cover the shock tubes with sand bags in the future to prevent further misfires. Premature and sympathetic detonations were avoided by using the proper timing and explosives. Explosives residue and leakage into the reservoir were avoided by using fixed cartridge explosives and proper timing. Overbreak on final faces was minimized by using trim holes with light decoupled charges.

Statistics for each blast are given in Table 1. The first blast utilized the lowest weight of explosives per delay and the lowest total weight of explosives of any of the blasts. The contractor gradually increased the weight per delay and total weight of explosives with successive blasts until a suitable production level was reached. The contractor submitted a blast plan before each blast for USACE evaluation and a post blasting report for USACE records. The contractor exhibited good cooperation with USACE to insure all instruments were ready to properly record the effects of each blast. USACE geotechnical and structural personnel reviewed the instrument response data after each blast before giving approval to proceed with a subsequent blast.

4 INSTRUMENTATION DATA

4.1 Summary of Instrumentation

The types of instruments used to measure the effects of blasting on the existing critical structures are given in Table 2 along with threshold and limit values. Limit values are set at levels below which the existing structures will remain operable and undamaged by blasting. Threshold values are set below limit values to serve as a warning level that will trigger a change in blasting procedures to prevent responses beyond the limit value (see the existing structures protection plan for further details). The locations of instruments are given in Figures 2 and 3. Data from crack meters, strain gages, and piezometers were collected dynamically to allow accurate collection of the peak movement, strain and change in water pressure during individual blasts. The contractor deployed geophones (in addition to USACE operated instruments) during the 1150 bench blasting to collect data for establishing site specific vibration attenuation constants (see discussion below).

The threshold and limit values for crack meters were designed to detect excessive movement on cracks and concrete joints. Two crack meters (CM_0017 and CM_0018) were installed across expansion joints on the outlet tower bridge. Since these joints experience normal temperature induced displacements of 0.125 inch as measured by the structures protection instrumentation, the construction threshold and limit values for these two instruments were determined to be 0.25 inch and 0.5 inch, respectively.

4.2 Instrumentation Results

No limits or thresholds were exceeded during blasting or in the period since blasting due to construction activities for any of the structure protection instruments listed in Table 2.

4.2.1 Crack Meters

Crack meter maximum displacement values were typically less than 10% of the threshold value for all crack meters except tunnel crack meters CM_0010 and CM_0011 (Table 3). Crack meter CM_0010 only exceeded 10% of the threshold during two blasts, the peak value of about 17% occurring during the first blast. Crack meters CM_0011 and CM_0018 malfunctioned during the dynamic recording of some or all blasts, rendering results from these meters questionable.

4.2.2 Geophones

All peak particle velocities as recorded by geophones on the structures were less than 10% of threshold values (Table 4). The peak particle velocities from the contractor's geophones and the Corps' geophones were plotted vs. scaled distance (Figure 4) to develop site specific attenuation constants for the following equations:

$$PPV = K(D_s)^m$$

$$D_s = D/W^{0.5}$$

where: PPV = peak particle velocity (in/s).
K and m = site attenuation constants.
D_s = scaled distance (ft/lb$^{0.5}$).
D = distance from blast to nearest structure (ft).
W = maximum charge weight per delay (lb)

The attenuation constants K and m are derived by fitting a regression to the plotted peak particle velocity and scaled distance data on a log-log plot. K is the Y-intercept of the regression line and m is the slope. A hand fit regression through all data collected from USACE and contractor instruments yields values of m = -1 and K = 50. These values may be used when predicting peak particle velocities from future blasting events and will be refined as blasting proceeds to allow better prediction of the effects of blasts and improve the design of all subsequent blasts to prevent values above the contract threshold values for peak particle velocities.

4.2.3 Strain Gages

Dynamic strain monitoring is intended to monitor strain effects of a single blast event. The short durations of the blast events do not include thermal effects to the structure. Dynamic strain as measured by strain gages were generally less than 10 percent of the threshold value of 100 micro strain (Table 5). The maximum recorded strain was 28 percent of the threshold. Therefore, short term (dynamic) strain thresholds and limits will remain unchanged.

Static strain over time is intended to show long term, accumulative effects of blasting and excavation. Static strain has exceed threshold values due to relatively large, natural thermal effects, not blast effects. Volumetric changes in concrete have responded to ambient air temperature and water temperature changes. These effects have always existed. . To accomplish the intent of the monitoring program, those variations in strain that have close correlation to temperature changes will be evaluated for long term trends not attributed to temperature changes.. It is important to note that there are daily and seasonal temperature changes. Strain gages are located in areas that do not received direct sun light, but are located where they are inundated for periods of time. Thus both water temperature and air temperature are factors. For long term effects, threshold and limit values have been increased to include thermal effects.

4.2.4 Piezometers

Piezometers were installed to measure the effectiveness of dewatering during excavation and construction behind the cofferdam. Piezometers measured a dynamic response to the blasts as pressure waves moved through the formation. However, threshold and limit values for piezometers are related to dewatering activities and were not evaluated as part of the test blasting.

4.2.5 Inclinometers

It was anticipated that the 1150 bench excavation would have no impact on rotational changes of the rock mass, because the rock removed was minor and unlikely to affect the mass of rock containing the inclinometers. Thus, any changes recorded by inclinometers since May 2004 are likely due to temperature and reservoir elevation changes. The measured variability of the inclinometers due to temperature and reservoir changes was greater than the established threshold value of 30 arc seconds for all instruments. However, the log term average measured differential rotation was less than the thresholds. To avoid having threshold and limiting values that would routinely be exceeded by natural temperature and reservoir effects, the appropriate threshold and limiting values were re-evaluated (Shannon & Wilson, 2004). New values were established by estimating the amount of model predicted and empirically derived elastic displacement of the rock mass that could occur due to excavation. These analyses concluded that an appropriate threshold value for in-place inclinometer change in rotation is 200 arc seconds with a corresponding limiting value of 300 arc seconds.

4.2.6 Liquid Level System

The intent of the liquid level system is to monitor any short term or long term settlement or rotational movements of the tower and the third bridge pier. On the tower and the pier footing there are four liquid level gages each, one at each corner, and a fifth reference gage located on bedrock in close proximity to each structure.

Since the instrument reading collection began in May 2004, large thermal effects have been measured that overshadow blasting and excavation effects and in the long term exceed the established thresholds and limiting values for settlement and rotation. There are temperature changes that affect the liquid level system and there are temperature induced concrete volumetric changes. The dominant effect is presently unclear. The coefficient of expansion of concrete for 100 degree F is 0.00055. The instruments are located approximately 10 feet above the ground on two sides, south and west. Assuming a 40 degree differential over ten feet, one would see an expansion of 0.026 inches. Actual instrument readings are roughly in the range of 0.00 to 0.07 inches.

Past experience has shown that this type of liquid level system has accurately monitored movements in tunnels where temperatures are relatively constant between gages. Thermal effects are producing inaccuracies when these instruments exposed to unequal ambient temperatures and sun exposure at Howard Hanson Dam. The daily cycles of uneven temperature have produced cyclical gage readings in excess of expected or actual tower and bridge footing movements resulting from blasting. Although the liquid accurately seeks its level at any temperature, the differential temperatures of just a few degrees affect localized densities of liquid. This fluid density differential creates a buoyancy differential for the floats in each of the gages. These floats allow measurements of the structure elevation relative to the level of the liquid. Attempts have been made to insulate the liquid level system in the hope of creating a consistent temperature for one end of the system to the other, but without complete success.

Discussions were held with Shannon & Wilson, the installer of the system, concerning a resolution of temperature effects on both structure and instrumentation. Numeric temperature corrections were discussed. More study is underway to normalize the data by filtering out effects not related to blasting. One thermal effect on the structure has to do with reservoir level. Higher pools expose more of the structure to colder temperatures. Adjustments to the level measurements are also being considered as a function of pool elevation.

Existing threshold and limit values for the liquid level system will remain the same for the delta measurements immediately before and after a blast, relative to the reference gage. For long term level measurements including thermal effects, threshold and limit values have been increased to values well within permissible values (See Table 2). Two other sets of data will be added. In addition to movements at the corners of the tower relative to the reference gage, the maximum movement of the corner gages will be monitored relative to other corner gages. This will permit an improved assessment of tower rotation. For the cases where corner movements are measured relative to other corner gages, the threshold and limit values are doubled those measured relative to the reference gage. This was done to allow for the comparison of negative and positive values that could occur when one corner moves up while another corner moves down.

Data show that when the pool elevation went down, the tower expanded upward. This is consistent with warmer air temperatures. It was also noted that the northeast corner of the tower raised the most in spite of the fact it does not get the most sun exposure. This is accounted for by having the least restraint against the rock mass.

Two data plots will be added for the liquid level system. One will show the delta in all four corners immediately before and after a blast, approximately a one hour interval. This will show effects of blasting without including thermal effects. The other plot will show the rotational effect of differential movement of the corners by projecting a line normal to a best fit of the four corners, up to top of tower. Thus showing estimated movement at the top of tower.

4.3 Instrumentation Problems

Crack meter CM_0006 functioned during the test blasts but one of the coils failed on 4 June. A replacement transducer has been ordered and will be installed prior to blasting this fall.

Crack meter 0011, also in the tunnel, never did function properly for any of the blasts. This sensor will be reset prior to blasting.

Crack meter CM_0018 malfunctioned during portions of the early blasts. This instrument was reset on 20 May. It appears that on the 26 May blast there was an additional failure. This sensor will be monitored closely when blasting resumes. If it fails again it will be replaced.

Strain gages SG_0001 & SG_0002 are read manually before and after each blast. These were read improperly during the test blasting, but will be read correctly for future blasts. Strain gage SG_0003 is inoperable but will also be replaced prior to blasting this fall.

Geophone 1104 did not respond to any of the blasts and will be replaced or repaired prior to the resumption of blasting.

The automated data acquisition system (ADAS) and web site posting portion of the instrumentation system worked well during the test blast period and continues to function. A few data management and plotting problems were noted and have subsequently been fixed.

4.4 Proposed Additional Instruments

One additional crack meter has been ordered to be installed on the pre-existing crack at approximately elevation 1069 inside the base of the intake tower (see discussion below). This will be installed in mid-September prior to further blasting.

5 ESPP PROCEDURES EVALUATION

The ESPP procedures worked well and are adequate to insure protection of the existing structures. The ESPP requires that designer review of each blast be performed prior to a subsequent blast. This worked well as geotechnical and structural engineering staff need to review the post blast data to understand the data's long term consequences for structures as well as check the threshold and limit values.

Visual inspections are required after each blast. After all but one blast, no unusual or anomalous changes were noticed to any of the existing structures. After blast 7 one inspector noticed what he thought was a slight increase in seepage down at elevation 1067. There was no way to quantify the seepage. Following blast 7, a more thorough inspection of tower cracks was made, attempting to trace hairline cracks to their termination. Some small cracks were observed that had not been noted previously, but were likely there all along. Cracks were highlighted with red paint and a pencil mark drawn at what first appeared to be the end of the cracks. Where cracks now extend beyond the pencil marks apparently is where paint had originally spanned the crack, but soon thereafter penetrated the cracks and additional crack length became visible.

On one of the last blasts, a video camera was set up to visually monitor the crack at elevation 1070, as the blast occurred, on the theory that the crack could open and close quickly without longer term effects. Nothing was observed. An additional crack meter will be installed on this horizontal crack, prior to further blasting. The crack meter will record any dynamic motions that may occur. (This is the crack with major calcification that has been noted for many years in the PI reports).

Instrumentation interpretation results procedures were re-examined after the test blasting. It was decided that a dedicated person should be responsible for examining all data within one hour after each blast. One person from Shannon & Wilson and one from Seattle District (Steve Meyerholtz POC) will be identified prior to each blast as the responsible persons to perform this data evaluation (see Existing Structures Protection Plan).

Communication between members of the ESP team was adequate to insure all parties were aware of the results of the data. No communication mishaps occurred.

6 CONCLUSIONS/LESSONS LEARNED

Data collected during the test blast indicate that controlled blasting techniques are likely to be protective of existing critical structures. The array of instruments used to monitor the structures appears to be adequate to insure that stresses on the structures are accurately measured. Dynamic instrument sampling provides unique and valuable data concerning the response of the structure to the blasts. The liquid level system is extremely sensitive to temperature and results must be interpreted carefully.

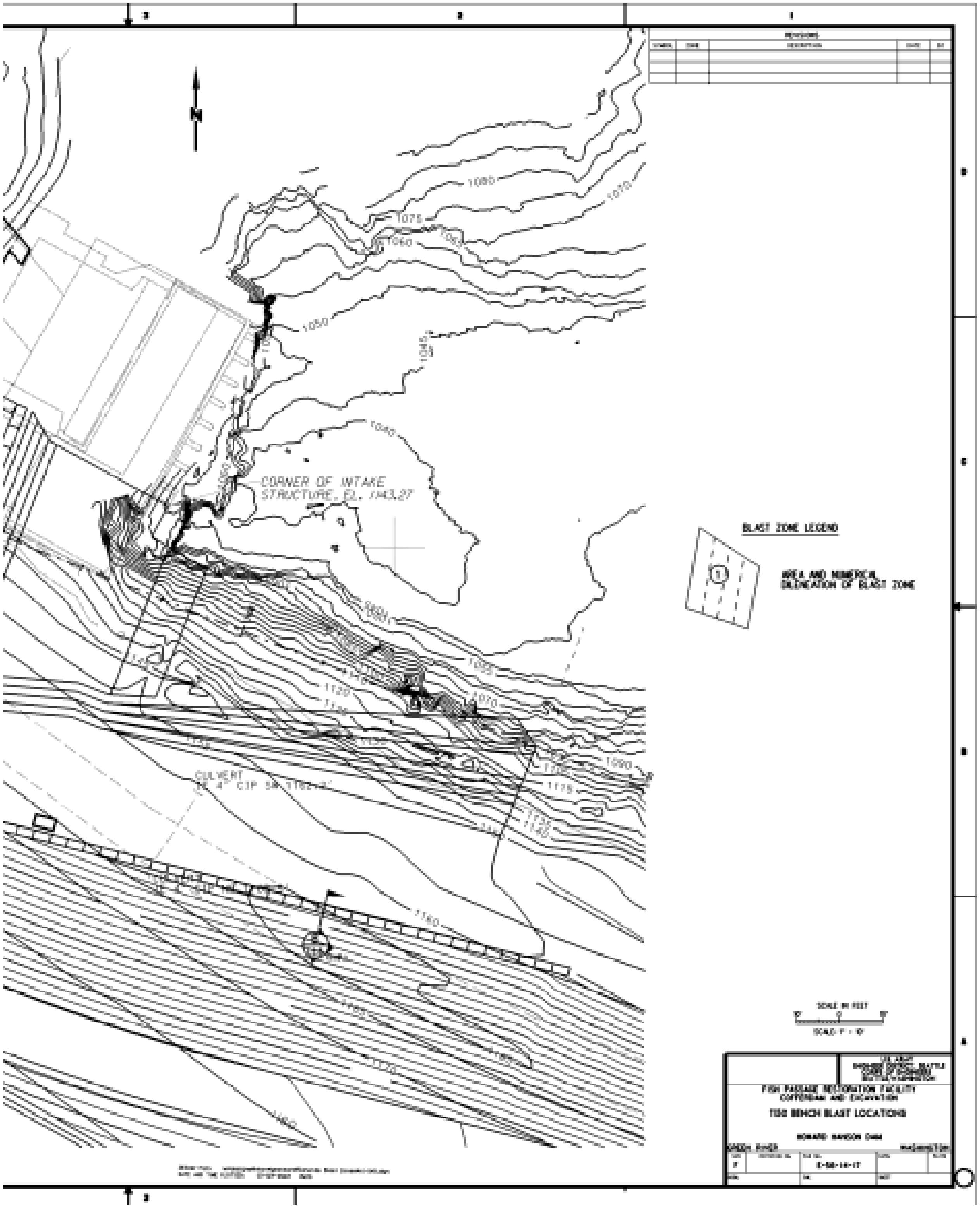
7 RECOMMENDATIONS

The contractor should be allowed to proceed, according to his submitted plans, with blasting adjacent to the existing outlet tower for the cofferdam beginning in late September or early October 2004. Additional instrumentation as discussed above should be installed and tested prior to resumption of blasting.

8 REFERENCES

Shannon & Wilson, 2004. Technical Memorandum – RE: Howard Hanson Dam Fish Passage Facility, Exiting Structures Instrumentation Program, In-Place Inclinometer Thresholds and Limits.

U.S. Army Corps of Engineers, 2004. Existing Structures Protection Plan during Fish Passage Facility Excavation, Supplement Number 1, Howard A. Hanson Dam.



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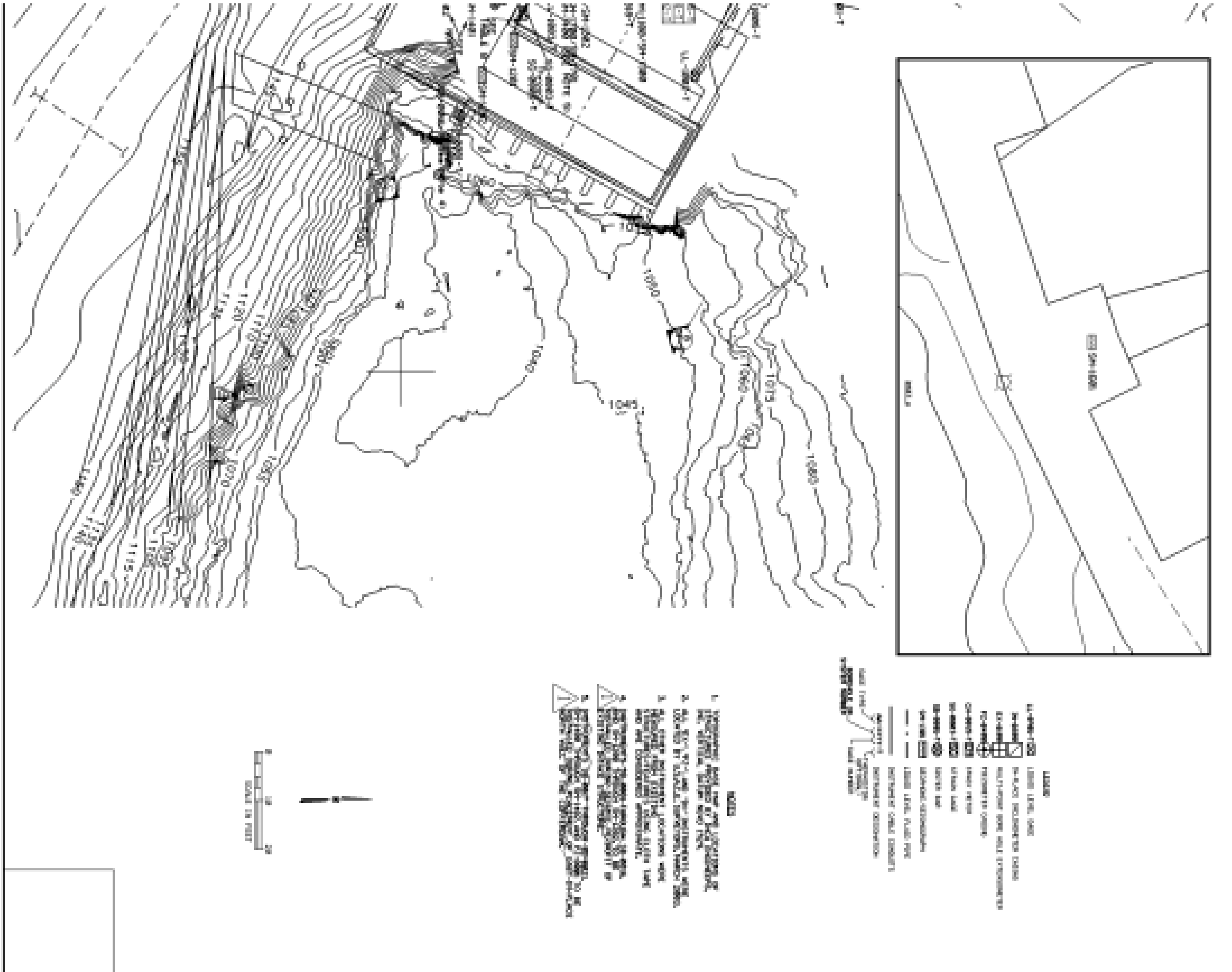
BLAST ZONE LEGEND
AREA AND NUMERICAL
DELINEATION OF BLAST ZONE
SCALE IN FEET
FISH PASSAGE RESTORATION FACILITY
COFFERDAM AND EXCAVATION
BENCH BLAST LOCATIONS
HOWARD HANSON DAM
GREEN RIVER
WASHINGTON



HOWARD A. HANSON DAM
FISH PASSAGE FACILITY
EXISTING STRUCTURE INSTRUMENTATION

U.S. ARMY CORPS OF ENGINEERS
ENGINEER DISTRICT, SEATTLE
SEATTLE, WASHINGTON

S & W JOB NUMBER: 21-1-09755-003

INSTRUMENTATION ON EXISTING STRUCTURES

SURFACE SITE PLAN

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PLATE
GT-1A

LIQUID LEVEL SCHEDULE

LIQUID LEVEL GAGE DESIGNATION	INSTR. COORDINATES NORTHING	INSTR. COORDINATES EASTING	INSTRUMENT ELEV., FT.	COMMENTS
LL-0901-T	182615	1763462	1164	BRIDGE PIER 3 - REFERENCE GAGE (0901) LOCATED APPROX. 40' NE OF PIER
LL-0902-T	182528	1763472	1164	
LL-0903-T	182517	1763483	1164	
LL-0904-T	182502	1763464	1164	
LL-0905-T	182513	1763454	1164	
LL-1001-T	182523	1763519	1149	GATE TOWER - REFERENCE GAGE (1001) LOCATED APPROX. 30' N OF TOWER
LL-1002-T	182412	1763545	1149	
LL-1003-T	182441	1763498	1149	
LL-1004-T	182477	1763517	1149	
LL-1005-T	182454	1763566	1149	

SEISMOGRAPH/GEOPHONE SCHEDULE

INSTRUMENT DESIGNATION	PREVIOUS INST. DESIGNATION	INSTR. COORDINATES NORTHING	INSTR. COORDINATES EASTING	INSTRUMENT ELEV., FT.	GEOPHONE/INSTRUMENT LOCATION	COMMENTS
SM-1101	SM4-0006	182450	1763496	1045	OUTLET TUNNEL - SOUTH SIDEWALLS	HIGH FREQUENCY UNIAXIAL GEOPHONES
SM-1102	SM4-0007	182464	1763473	1043		
SM-1103	SM4-0008	182477	1763451	1041		
SM-1104	SM4-0009	182490	1763430	1040		
SM-1100				1140	GAGE TOWER STAIRWAY	READOUT UNIT ONLY
SM-1200		182437	1763514	1230	TOP FLOOR GATE TOWER	READOUT UNIT ONLY
SM-1201	SM4-0005	182423	1763520	1140	INTAKE STRUCTURE DECK	TRIAXIAL GEOPHONE
SM-1202	SM4-0002	182412	1763541	1140	INTAKE STRUCTURE	HF DOWNHOLE GEOPHONE SEE NOTE 1
SM-1300	SM4-0003	182437	1763514	1140	GATE TOWER STAIRWAY	READOUT UNIT ONLY
SM-1301	SM4-0004	182437	1763514	1140	GATE TOWER'S WALL	HF TRIAX. GEOPHONE
SM-1401	SM4-0001	182437	1763514	1035		
SM-1400		182437	1763514	1230	TOP FLOOR GATE TOWER	READOUT UNIT ONLY
SM-1401	SM4-0012	TBD	TBD	TBD	COFFERDAM	TRIAXIAL GEOPHONE
SM-1402	SM4-0013	TBD	TBD	TBD		HF TRIAX. GEOPHONE SEE NOTE 2
SM-1501	SM4-0010	182518	1763488	1178	BRIDGE PIER	READOUT/GEOPHONE
SM-1601	SM4-0011	182592	1763425	1250	SPILLWAY	READOUT/GEOPHONE
SM-1700		182437	1763514	1230	TOP FLOOR GATE TOWER	READOUT UNIT ONLY
SM-1701		182437	1763514	1230		TRIAXIAL GEOPHONE

THERMISTOR SCHEDULE

THERMISTOR DESIGNATION	INSTR. COORDINATES NORTHING	INSTR. COORDINATES EASTING	ESTIMATED INSTRUMENT ELEV., FT	COMMENTS
CH-0006T	182460	1763467	1029	OUTLET TUNNEL
CH-0007T	182474	1763467	1048	
EX-0101T	182454.2	1763483.6	1160.24	ROCK PILLAR MPBX REFERENCE HEADS
EX-0201T	182482.5	1763454.26	1161.36	
EX-0301T	182520.2	1763421.21	1165.51	

VIBRATING WIRE SISTER BAR SCHEDULE

SISTER BAR DESIGNATION	INSTR. COORDINATES NORTHING	INSTR. COORDINATES EASTING	ESTIMATED GAGE ELEV., FT	GAGE ORIENTATION	COMMENTS
SB-0001-T	182411.8	1763544.8	1067	VERTICAL	EXISTING INTAKE STRUCTURE - SPACIAL WALL SEE NOTE 1
SB-0002-T	182410.5	1763546.5	1067		
SB-0003-T	182410.2	1763544	1067		
SB-0004-T	182409	1763545.5	1067		
SB-0005-T	182411.8	1763544.8	1084		
SB-0006-T	182410.5	1763546.5	1084		
SB-0007-T	182410.2	1763544	1084		
SB-0008-T	182409	1763545.5	1084		
SB-0009-T	182411.8	1763544.8	1098		
SB-0010-T	182410.5	1763546.5	1098		
SB-0011-T	182410.2	1763544	1098		
SB-0012-T	182409	1763545.5	1098		
SB-0013-T	182411.8	1763544.8	1126		
SB-0014-T	182410.5	1763546.5	1126		
SB-0015-T	182410.2	1763544	1126		
SB-0016-T	182409	1763545.5	1126		
SB-0017-T	182425	1763525	1050	VERTICAL	NEW COFFERDAM - NORTH CAST-IN-PLACE WALL SEE NOTE 2
SB-0018-T	182425	1763525	1075		
SB-0019-T	182425	1763525	TBD		
SB-0020-T	182425	1763525	TBD		
SB-0021-T	182425	1763525	TBD		

NOTES

1. INSTRUMENTATION TO BE INSTALLED DURING SEISMIC RETRO-FIT OF INTAKE STRUCTURE.
2. INSTRUMENTATION TO BE INSTALLED DURING CONSTRUCTION OF COFFERDAM.

HOWARD A. HANSON DAM
FISH PASSAGE FACILITY
EXISTING STRUCTURE INSTRUMENTATION

U.S. ARMY CORPS OF ENGINEERS
ENGINEER DISTRICT, SEATTLE
SEATTLE, WASHINGTON

S & W JOB NUMBER: 21-1-09755-003

INSTRUMENTATION ON EXISTING STRUCTURES
INSTRUMENT SCHEDULE

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PLATE
GT-2

Figure 4. Peak particle velocity versus scaled distance for all geophone data.

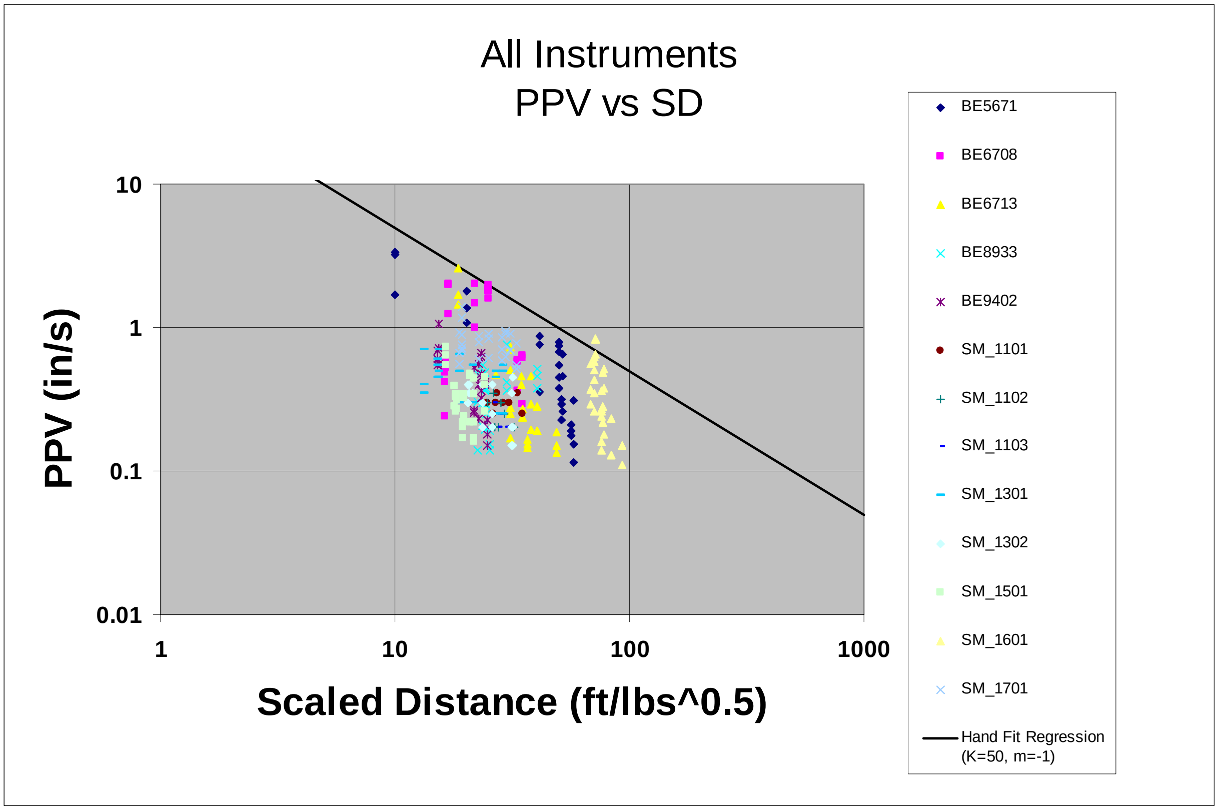

Table 1. Blast statistics.

Blast Number	Date	Approx. Distance to Nearest Structure (feet)	Maximum Charge Weight per Delay (lbs)	Volume Blasted (yd^3)	Total Weight of Explosives (lbs)
1	6-May-04	70	17.8	330	297
2	11-May-94	83	18.5	300	330
3	12-May-04	101	19	300	330
4	13-May-04	70	20	430	456
5	17-May-04	68	19	450	442
6	18-May-04	83	18.5	300	330
7	19-May-04	63	22	435	470
8	20-May-04	58	19	450	411
9	21-May-04	58	17	405	327
10[1]	25-May-04	82	0.33	20-30	1.3
11	26-May-04	78	17	430	475

Notes

1 Blasting boulders.

Table 2. Revised instrumentation threshold and limit values.

INSTRUMENT	THRESHOLD VALUE	LIMITING VALUE
Vibrating Wire Piezometer	Groundwater <5' below adjacent subgrade elevation	Groundwater equal to adjacent subgrade elevation
Inclinometer – In-Place	Change in Slope = 200 Arc Seconds	Change in Slope = 300 Arc Seconds
Inclinometer – Survey	0.0005H	0.001H
Multi-Point Borehole Extensometers	0.01 ft	0.04 ft
Liquid Level Gages (relative to reference gage)	0.01/0.1 inch[1]	0.02/0.2 inch[1]
Liquid Level Gages (gage to gage)	0.02/0.2 inch[1]	0.04/0.4 inch[1]
Crack Meters	0.05/0.25[2] in	0.1/0.5[2] in
Strain Gages	100/500 µstrain[1]	250/1000 µstrain[1]
Sister Bars	125/250 µstrain[1]	250/450 µstrain[1]
Load Cells	5 kip increase in load	10 kip increase in load
Geophones – Reinforced Concrete	16 in/s	20 in/s
Geophones – Other Structures	6 in/s	8 in/s

1. Low values are for delta immediately pre- and post-blast. Higher values are for long-term.

2. Higher threshold and limit values are for bridge deck joint meters CM_0017 and CM_0018.

Table 3. Summary of Crack Meter dynamic Measurement Results.

Table 3a - Dynamic Crack Meter Blast Results

Blast Number	Date	Gage ID	Location	Displacement (inches) Max Threshold	Peak Max	Peak Min	Offset[1]	% Max Threshold	% Min Threshold
1	5/6/2004 3:05	CM_0001	S Outlet Tunnel; 15+16 Wall	0.05	0.0020	-0.0023	-0.0002	4.0	4.6
	5/6/2004 3:05	CM_0002	S Outlet Tunnel; 15+40 Wall	0.05	0.0025	-0.0021	0	5.0	4.2
	5/6/2004 3:05	CM_0003	S Outlet Tunnel; 15+40 Ceiling	0.05	0.0011	-0.0010	0	2.2	2.0
	5/6/2004 3:05	CM_0004	S Outlet Tunnel; 15+50 Ceiling	0.05	0.0012	-0.0010	0	2.4	2.0
	5/6/2004 3:05	CM_0005	S Outlet Tunnel; 15+65 Wall	0.05	0.0012	-0.0010	0	2.4	2.0
	5/6/2004 3:05	CM_0006	S Outlet Tunnel; 15+68 Wall	0.05	0.0017	-0.0017	-0.0001	3.4	3.4
	5/6/2004 3:05	CM_0007	S Outlet Tunnel; 15+71 Ceiling	0.05	0.0026	-0.0019	0.0001	5.2	3.8
	5/6/2004 3:05	CM_0008	S Outlet Tunnel; 15+86 Ceiling	0.05	0.0018	-0.0020	-0.0001	3.6	4.0
	5/6/2004 3:05	CM_0009	S Outlet Tunnel; 15+86 Wall	0.05	0.0016	-0.0008	0.0001	3.2	1.6
	5/6/2004 3:05	CM_0010	S Outlet Tunnel; 15+95 Ceiling	0.05	0.0086	-0.0067	0.0009	17.2	13.4
	5/6/2004 3:05	CM_0011	S Outlet Tunnel; 15+98 Wall	0.05	0.0109	-0.0113	NA[2]	21.8	22.5
	5/6/2004 3:05	CM_0012	S Outlet Tunnel; 16+27 Wall	0.05	0.0036	-0.0030	-0.0005	7.2	6.0
	5/6/2004 3:05	CM_0013	N Outlet Tunnel; 15+48 Ceiling	0.05	0.0014	-0.0015	-0.0001	2.8	3.0
	5/6/2004 3:05	CM_0014	N Outlet Tunnel; 15+66 Ceiling	0.05	0.0014	-0.0013	0	2.8	2.6
	5/6/2004 3:05	CM_0015	Pier 3 Footing SW	0.05	0.0024	-0.0023	-0.0001	4.8	4.6
	5/6/2004 3:05	CM_0016	Pier 3 Footing SE	0.05	0.0015	-0.0017	-0.0002	3.0	3.4
	5/6/2004 3:05	CM_0017	Bridge Deck Elev 1230 @ Pier 3	0.25	0.0131	-0.0181	-0.0002	5.2	7.2
	5/6/2004 3:05	CM_0018	Bridge Deck Elev 1230 @ Tower	0.25	0.0104	-0.0133	-0.0004	4.2	5.3
2	5/11/2004 2:05	CM_0001	S Outlet Tunnel; 15+16 Wall	0.05	0.0011	-0.0021	-0.0001	2.2	4.2
	5/11/2004 2:05	CM_0002	S Outlet Tunnel; 15+40 Wall	0.05	0.0014	-0.0017	0	2.8	3.4
	5/11/2004 2:05	CM_0003	S Outlet Tunnel; 15+40 Ceiling	0.05	0.0009	-0.0013	0	1.8	2.6
	5/11/2004 2:05	CM_0004	S Outlet Tunnel; 15+50 Ceiling	0.05	0.0011	-0.0012	0	2.2	2.4
	5/11/2004 2:05	CM_0005	S Outlet Tunnel; 15+65 Wall	0.05	0.0010	-0.0010	0	2.0	2.0
	5/11/2004 2:05	CM_0006	S Outlet Tunnel; 15+68 Wall	0.05	0.0014	-0.0019	0	2.8	3.8
	5/11/2004 2:05	CM_0007	S Outlet Tunnel; 15+71 Ceiling	0.05	0.0019	-0.0020	0	3.8	4.0
	5/11/2004 2:05	CM_0008	S Outlet Tunnel; 15+86 Ceiling	0.05	0.0012	-0.0013	0	2.4	2.6
	5/11/2004 2:05	CM_0009	S Outlet Tunnel; 15+86 Wall	0.05	0.0012	-0.0008	0	2.4	1.6
	5/11/2004 2:05	CM_0010	S Outlet Tunnel; 15+95 Ceiling	0.05	0.0061	-0.0062	0.0001	12.2	12.4
	5/11/2004 2:05	CM_0011	S Outlet Tunnel; 15+98 Wall	0.05	0.0100	-0.0063	NA[2]	20.0	12.6
	5/11/2004 2:05	CM_0012	S Outlet Tunnel; 16+27 Wall	0.05	0.0046	-0.0021	0.0006	9.2	4.2
	5/11/2004 2:05	CM_0013	N Outlet Tunnel; 15+48 Ceiling	0.05	0.0018	-0.0015	0	3.6	3.0
	5/11/2004 2:05	CM_0014	N Outlet Tunnel; 15+66 Ceiling	0.05	0.0020	-0.0017	-0.0001	4.0	3.4
	5/11/2004 2:05	CM_0015	Pier 3 Footing SW	0.05	0.0026	-0.0033	0	5.2	6.6
	5/11/2004 2:05	CM_0016	Pier 3 Footing SE	0.05	0.0031	-0.0029	0	6.2	5.8
	5/11/2004 2:05	CM_0017	Bridge Deck Elev 1230 @ Pier 3	0.25	0.0098	-0.0121	-0.0002	3.9	4.8
	5/11/2004 2:05	CM_0018	Bridge Deck Elev 1230 @ Tower	0.25	0.0126	-0.0193	-0.0004	5.0	7.7
3	5/12/2004 2:05	CM_0001	S Outlet Tunnel; 15+16 Wall	0.05	0.0024	-0.0022	-0.0001	4.8	4.4
	5/12/2004 2:05	CM_0002	S Outlet Tunnel; 15+40 Wall	0.05	0.0015	-0.0015	0	3.0	3.0
	5/12/2004 2:05	CM_0003	S Outlet Tunnel; 15+40 Ceiling	0.05	0.0009	-0.0012	0	1.8	2.4
	5/12/2004 2:05	CM_0004	S Outlet Tunnel; 15+50 Ceiling	0.05	0.0012	-0.0018	0	2.4	3.6
	5/12/2004 2:05	CM_0005	S Outlet Tunnel; 15+65 Wall	0.05	0.0010	-0.0010	0	2.0	2.0
	5/12/2004 2:05	CM_0006	S Outlet Tunnel; 15+68 Wall	0.05	0.0012	-0.0013	0	2.4	2.6
	5/12/2004 2:05	CM_0007	S Outlet Tunnel; 15+71 Ceiling	0.05	0.0017	-0.0015	0	3.4	3.0
	5/12/2004 2:05	CM_0008	S Outlet Tunnel; 15+86 Ceiling	0.05	0.0014	-0.0021	0	2.8	4.2
	5/12/2004 2:05	CM_0009	S Outlet Tunnel; 15+86 Wall	0.05	0.0008	-0.0011	0	1.6	2.2
	5/12/2004 2:05	CM_0010	S Outlet Tunnel; 15+95 Ceiling	0.05	0.0032	-0.0042	-0.0003	6.4	8.4
	5/12/2004 2:05	CM_0011[2]	S Outlet Tunnel; 15+98 Wall	0.05	0.0102	-0.0075	NA[2]	20.4	15.0
	5/12/2004 2:05	CM_0012	S Outlet Tunnel; 16+27 Wall	0.05	0.0039	-0.0023	0.0006	7.8	4.6
	5/12/2004 2:05	CM_0013	N Outlet Tunnel; 15+48 Ceiling	0.05	0.0017	-0.0031	-0.0001	3.4	6.2
	5/12/2004 2:05	CM_0014	N Outlet Tunnel; 15+66 Ceiling	0.05	0.0012	-0.0011	0	2.4	2.2
	5/12/2004 2:05	CM_0015	Pier 3 Footing SW	0.05	0.0017	-0.0013	0	3.4	2.6
	5/12/2004 2:05	CM_0016	Pier 3 Footing SE	0.05	0.0020	-0.0020	-0.0001	4.0	4.0
	5/12/2004 2:05	CM_0017	Bridge Deck Elev 1230 @ Pier 3	0.25	0.0109	-0.0137	-0.0005	4.4	5.5
	5/12/2004 2:05	CM_0018	Bridge Deck Elev 1230 @ Tower	0.25	0.0097	-0.0167	-0.0003	3.9	6.7

Table 3a - Dynamic Crack Meter Blast Results

Blast Number	Date	Gage ID	Location	Displacement (inches) Max Threshold	Peak Max	Peak Min	Offset[1]	% Max Threshold	% Min Threshold
4	5/13/2004 2:05	CM_0001	S Outlet Tunnel; 15+16 Wall	0.05	0.0025	-0.0028	-0.0001	5.0	5.6
	5/13/2004 2:05	CM_0002	S Outlet Tunnel; 15+40 Wall	0.05	0.0014	-0.0011	0	2.8	2.2
	5/13/2004 2:05	CM_0003	S Outlet Tunnel; 15+40 Ceiling	0.05	0.0015	-0.0012	0	3.0	2.4
	5/13/2004 2:05	CM_0004	S Outlet Tunnel; 15+50 Ceiling	0.05	0.0012	-0.0012	0	2.4	2.4
	5/13/2004 2:05	CM_0005	S Outlet Tunnel; 15+65 Wall	0.05	0.0011	-0.0010	-0.0001	2.2	2.0
	5/13/2004 2:05	CM_0006	S Outlet Tunnel; 15+68 Wall	0.05	0.0015	-0.0017	0	3.0	3.4
	5/13/2004 2:05	CM_0007	S Outlet Tunnel; 15+71 Ceiling	0.05	0.0019	-0.0022	0	3.8	4.4
	5/13/2004 2:05	CM_0008	S Outlet Tunnel; 15+86 Ceiling	0.05	0.0012	-0.0015	0	2.4	3.0
	5/13/2004 2:05	CM_0009	S Outlet Tunnel; 15+86 Wall	0.05	0.0009	-0.0008	0	1.8	1.6
	5/13/2004 2:05	CM_0010	S Outlet Tunnel; 15+95 Ceiling	0.05	0.0032	-0.0036	-0.0001	6.4	7.2
	5/13/2004 2:05	CM_0011	S Outlet Tunnel; 15+98 Wall	0.05	NA[2]	NA[2]	NA[2]	NA[2]	NA2
	5/13/2004 2:05	CM_0012	S Outlet Tunnel; 16+27 Wall	0.05	0.0022	-0.0034	-0.0003	4.4	6.8
	5/13/2004 2:05	CM_0013	N Outlet Tunnel; 15+48 Ceiling	0.05	0.0016	-0.0013	-0.0001	3.2	2.6
	5/13/2004 2:05	CM_0014	N Outlet Tunnel; 15+66 Ceiling	0.05	0.0018	-0.0017	0	3.6	3.4
	5/13/2004 2:05	CM_0015	Pier 3 Footing SW	0.05	0.0017	-0.0025	0	3.4	5.0
	5/13/2004 2:05	CM_0016	Pier 3 Footing SE	0.05	0.0019	-0.0016	-0.0001	3.8	3.2
	5/13/2004 2:05	CM_0017	Bridge Deck Elev 1230 @ Pier 3	0.25	0.0099	-0.0131	-0.0004	4.0	5.2
	5/13/2004 2:05	CM_0018	Bridge Deck Elev 1230 @ Tower	0.25	0.0668	-0.0401	-0.0001	26.7	16.0
5	5/17/2004 1:05	CM_0001	S Outlet Tunnel; 15+16 Wall	0.05	0.0033	-0.0039	-0.0002	6.6	7.8
	5/17/2004 1:05	CM_0002	S Outlet Tunnel; 15+40 Wall	0.05	0.0017	-0.0020	0	3.4	4.0
	5/17/2004 1:05	CM_0003	S Outlet Tunnel; 15+40 Ceiling	0.05	0.0008	-0.0009	0	1.6	1.8
	5/17/2004 1:05	CM_0004	S Outlet Tunnel; 15+50 Ceiling	0.05	0.0012	-0.0013	0	2.4	2.6
	5/17/2004 1:05	CM_0005	S Outlet Tunnel; 15+65 Wall	0.05	0.0013	-0.0010	0	2.6	2.0
	5/17/2004 1:05	CM_0006	S Outlet Tunnel; 15+68 Wall	0.05	0.0015	-0.0016	-0.0001	3.0	3.2
	5/17/2004 1:05	CM_0007	S Outlet Tunnel; 15+71 Ceiling	0.05	0.0024	-0.0031	0	4.8	6.2
	5/17/2004 1:05	CM_0008	S Outlet Tunnel; 15+86 Ceiling	0.05	0.0012	-0.0012	0	2.4	2.4
	5/17/2004 1:05	CM_0009	S Outlet Tunnel; 15+86 Wall	0.05	0.0009	-0.0009	0	1.8	1.8
	5/17/2004 1:05	CM_0010	S Outlet Tunnel; 15+95 Ceiling	0.05	0.0026	-0.0043	-0.0002	5.2	8.6
	5/17/2004 1:05	CM_0011	S Outlet Tunnel; 15+98 Wall	0.05	0.0110	-0.0093	NA[2]	22.0	18.6
	5/17/2004 1:05	CM_0012	S Outlet Tunnel; 16+27 Wall	0.05	0.0026	-0.0032	-0.0003	5.2	6.4
	5/17/2004 1:05	CM_0013	N Outlet Tunnel; 15+48 Ceiling	0.05	0.0018	-0.0019	-0.0001	3.6	3.8
	5/17/2004 1:05	CM_0014	N Outlet Tunnel; 15+66 Ceiling	0.05	0.0013	-0.0017	-0.0001	2.6	3.4
	5/17/2004 1:05	CM_0015	Pier 3 Footing SW	0.05	0.0015	-0.0015	0	3.0	3.0
	5/17/2004 1:05	CM_0016	Pier 3 Footing SE	0.05	0.0021	-0.0024	0	4.2	4.8
	5/17/2004 1:05	CM_0017	Bridge Deck Elev 1230 @ Pier 3	0.25	0.0106	-0.0140	-0.0003	4.2	5.6
	5/17/2004 1:05	CM_0018	Bridge Deck Elev 1230 @ Tower	0.25	1.6144	-1.0653	-0.0002	NA[3]	NA3
6	5/18/2004 2:05	CM_0001	S Outlet Tunnel; 15+16 Wall	0.05	0.0034	-0.0050	-0.0001	6.8	10.0
	5/18/2004 2:05	CM_0002	S Outlet Tunnel; 15+40 Wall	0.05	0.0015	-0.0013	0	3.0	2.6
	5/18/2004 2:05	CM_0003	S Outlet Tunnel; 15+40 Ceiling	0.05	0.0010	-0.0013	0	2.0	2.6
	5/18/2004 2:05	CM_0004	S Outlet Tunnel; 15+50 Ceiling	0.05	0.0012	-0.0014	0	2.4	2.8
	5/18/2004 2:05	CM_0005	S Outlet Tunnel; 15+65 Wall	0.05	0.0011	-0.0010	-0.0001	2.2	2.0
	5/18/2004 2:05	CM_0006	S Outlet Tunnel; 15+68 Wall	0.05	0.0014	-0.0015	0	2.8	3.0
	5/18/2004 2:05	CM_0007	S Outlet Tunnel; 15+71 Ceiling	0.05	0.0013	-0.0017	0	2.6	3.4
	5/18/2004 2:05	CM_0008	S Outlet Tunnel; 15+86 Ceiling	0.05	0.0013	-0.0011	0	2.6	2.2
	5/18/2004 2:05	CM_0009	S Outlet Tunnel; 15+86 Wall	0.05	0.0006	-0.0008	0	1.2	1.6
	5/18/2004 2:05	CM_0010	S Outlet Tunnel; 15+95 Ceiling	0.05	0.0029	-0.0030	-0.0001	5.8	6.0
	5/18/2004 2:05	CM_0011	S Outlet Tunnel; 15+98 Wall	0.05	0.0060	-0.0048	-0.0002	12.0	9.6
	5/18/2004 2:05	CM_0012	S Outlet Tunnel; 16+27 Wall	0.05	0.0019	-0.0032	-0.0001	3.8	6.4
	5/18/2004 2:05	CM_0013	N Outlet Tunnel; 15+48 Ceiling	0.05	0.0016	-0.0011	-0.0001	3.2	2.2
	5/18/2004 2:05	CM_0014	N Outlet Tunnel; 15+66 Ceiling	0.05	0.0013	-0.0011	0	2.6	2.2
	5/18/2004 2:05	CM_0015	Pier 3 Footing SW	0.05	0.0019	-0.0018	0	3.8	3.6
	5/18/2004 2:05	CM_0016	Pier 3 Footing SE	0.05	0.0017	-0.0018	0	3.4	3.6
	5/18/2004 2:05	CM_0017	Bridge Deck Elev 1230 @ Pier 3	0.25	0.0124	-0.0150	-0.0003	5.0	6.0
	5/18/2004 2:05	CM_0018	Bridge Deck Elev 1230 @ Tower	0.25	0.0222	-0.0246	-0.0001	8.9	9.8

Table 3a - Dynamic Crack Meter Blast Results

Blast Number	Date	Gage ID	Location	Displacement (inches) Max Threshold	Peak Max	Peak Min	Offset[1]	% Max Threshold	% Min Threshold
7	5/19/2004 1:05	CM_0001	S Outlet Tunnel; 15+16 Wall	0.05	0.0048	-0.0069	0	9.6	13.8
	5/19/2004 1:05	CM_0002	S Outlet Tunnel; 15+40 Wall	0.05	0.0025	-0.0025	0	5.0	5.0
	5/19/2004 1:05	CM_0003	S Outlet Tunnel; 15+40 Ceiling	0.05	0.0009	-0.0011	0	1.8	2.2
	5/19/2004 1:05	CM_0004	S Outlet Tunnel; 15+50 Ceiling	0.05	0.0017	-0.0015	0	3.4	3.0
	5/19/2004 1:05	CM_0005	S Outlet Tunnel; 15+65 Wall	0.05	0.0009	-0.0010	0	1.8	2.0
	5/19/2004 1:05	CM_0006	S Outlet Tunnel; 15+68 Wall	0.05	0.0020	-0.0020	0	4.0	4.0
	5/19/2004 1:05	CM_0007	S Outlet Tunnel; 15+71 Ceiling	0.05	0.0017	-0.0020	0	3.4	4.0
	5/19/2004 1:05	CM_0008	S Outlet Tunnel; 15+86 Ceiling	0.05	0.0022	-0.0023	0	4.4	4.6
	5/19/2004 1:05	CM_0009	S Outlet Tunnel; 15+86 Wall	0.05	0.0006	-0.0009	0	1.2	1.8
	5/19/2004 1:05	CM_0010	S Outlet Tunnel; 15+95 Ceiling	0.05	0.0022	-0.0036	-0.0002	4.4	7.2
	5/19/2004 1:05	CM_0011	S Outlet Tunnel; 15+98 Wall	0.05	0.0074	-0.0070	NA[2]	14.9	13.9
	5/19/2004 1:05	CM_0012	S Outlet Tunnel; 16+27 Wall	0.05	0.0032	-0.0035	-0.0003	6.4	7.0
	5/19/2004 1:05	CM_0013	N Outlet Tunnel; 15+48 Ceiling	0.05	0.0017	-0.0012	-0.0001	3.4	2.4
	5/19/2004 1:05	CM_0014	N Outlet Tunnel; 15+66 Ceiling	0.05	0.0013	-0.0014	-0.0001	2.6	2.8
	5/19/2004 1:05	CM_0015	Pier 3 Footing SW	0.05	0.0021	-0.0015	0	4.2	3.0
	5/19/2004 1:05	CM_0016	Pier 3 Footing SE	0.05	0.0037	-0.0042	0	7.4	8.4
	5/19/2004 1:05	CM_0017	Bridge Deck Elev 1230 @ Pier 3	0.25	0.0109	-0.0126	-0.0001	4.4	5.0
	5/19/2004 1:05	CM_0018	Bridge Deck Elev 1230 @ Tower	0.25	0.4814	-0.4479	-0.0001	NA[3]	NA[3]
8	5/20/2004 2:05	CM_0001	S Outlet Tunnel; 15+16 Wall	0.05	0.0033	-0.0038	-0.0001	6.6	7.6
	5/20/2004 2:05	CM_0002	S Outlet Tunnel; 15+40 Wall	0.05	0.0013	-0.0015	0	2.6	3.0
	5/20/2004 2:05	CM_0003	S Outlet Tunnel; 15+40 Ceiling	0.05	0.0009	-0.0010	0	1.8	2.0
	5/20/2004 2:05	CM_0004	S Outlet Tunnel; 15+50 Ceiling	0.05	0.0009	-0.0009	0	1.8	1.8
	5/20/2004 2:05	CM_0005	S Outlet Tunnel; 15+65 Wall	0.05	0.0007	-0.0009	0	1.4	1.8
	5/20/2004 2:05	CM_0006	S Outlet Tunnel; 15+68 Wall	0.05	0.0011	-0.0013	0	2.2	2.6
	5/20/2004 2:05	CM_0007	S Outlet Tunnel; 15+71 Ceiling	0.05	0.0010	-0.0011	0.0001	2.0	2.2
	5/20/2004 2:05	CM_0008	S Outlet Tunnel; 15+86 Ceiling	0.05	0.0012	-0.0009	0	2.4	1.8
	5/20/2004 2:05	CM_0009	S Outlet Tunnel; 15+86 Wall	0.05	0.0007	-0.0007	0	1.4	1.4
	5/20/2004 2:05	CM_0010	S Outlet Tunnel; 15+95 Ceiling	0.05	0.0015	-0.0018	-0.0002	3.0	3.6
	5/20/2004 2:05	CM_0011	S Outlet Tunnel; 15+98 Wall	0.05	0.0123	-0.0102	NA[2]	24.5	20.5
	5/20/2004 2:05	CM_0012	S Outlet Tunnel; 16+27 Wall	0.05	0.0013	-0.0019	-0.0002	2.6	3.8
	5/20/2004 2:05	CM_0013	N Outlet Tunnel; 15+48 Ceiling	0.05	0.0013	-0.0010	-0.0001	2.6	2.0
	5/20/2004 2:05	CM_0014	N Outlet Tunnel; 15+66 Ceiling	0.05	0.0011	-0.0011	-0.0001	2.2	2.2
	5/20/2004 2:05	CM_0015	Pier 3 Footing SW	0.05	0.0012	-0.0014	0	2.4	2.8
	5/20/2004 2:05	CM_0016	Pier 3 Footing SE	0.05	0.0011	-0.0011	0	2.2	2.2
	5/20/2004 2:05	CM_0017	Bridge Deck Elev 1230 @ Pier 3	0.25	0.0145	-0.0211	0.0001	5.8	8.4
	5/20/2004 2:05	CM_0018	Bridge Deck Elev 1230 @ Tower	0.25	0.0161	-0.0209	0.0001	6.4	8.4
9	5/21/2004 2:05	CM_0001	S Outlet Tunnel; 15+16 Wall	0.05	0.0045	-0.0047	0	9.0	9.4
	5/21/2004 2:05	CM_0002	S Outlet Tunnel; 15+40 Wall	0.05	0.0011	-0.0015	0	2.2	3.0
	5/21/2004 2:05	CM_0003	S Outlet Tunnel; 15+40 Ceiling	0.05	0.0009	-0.0011	0	1.8	2.2
	5/21/2004 2:05	CM_0004	S Outlet Tunnel; 15+50 Ceiling	0.05	0.0008	-0.0012	0	1.6	2.4
	5/21/2004 2:05	CM_0005	S Outlet Tunnel; 15+65 Wall	0.05	0.0011	-0.0009	0	2.2	1.8
	5/21/2004 2:05	CM_0006	S Outlet Tunnel; 15+68 Wall	0.05	0.0009	-0.0012	0	1.8	2.4
	5/21/2004 2:05	CM_0007	S Outlet Tunnel; 15+71 Ceiling	0.05	0.0008	-0.0009	0	1.6	1.8
	5/21/2004 2:05	CM_0008	S Outlet Tunnel; 15+86 Ceiling	0.05	0.0011	-0.0009	0	2.2	1.8
	5/21/2004 2:05	CM_0009	S Outlet Tunnel; 15+86 Wall	0.05	0.0008	-0.0007	0	1.6	1.4
	5/21/2004 2:05	CM_0010	S Outlet Tunnel; 15+95 Ceiling	0.05	0.0019	-0.0020	-0.0001	3.8	4.0
	5/21/2004 2:05	CM_0011	S Outlet Tunnel; 15+98 Wall	0.05	0.0086	-0.0062	NA	17.2	12.4
	5/21/2004 2:05	CM_0012	S Outlet Tunnel; 16+27 Wall	0.05	0.0013	-0.0015	-0.0002	2.6	3.0
	5/21/2004 2:05	CM_0013	N Outlet Tunnel; 15+48 Ceiling	0.05	0.0012	-0.0013	0	2.4	2.6
	5/21/2004 2:05	CM_0014	N Outlet Tunnel; 15+66 Ceiling	0.05	0.0011	-0.0011	0	2.2	2.2
	5/21/2004 2:05	CM_0015	Pier 3 Footing SW	0.05	0.0011	-0.0012	0	2.2	2.4
	5/21/2004 2:05	CM_0016	Pier 3 Footing SE	0.05	0.0008	-0.0009	0	1.6	1.8
	5/21/2004 2:05	CM_0017	Bridge Deck Elev 1230 @ Pier 3	0.25	0.0128	-0.0156	0.0004	5.1	6.2
	5/21/2004 2:05	CM_0018	Bridge Deck Elev 1230 @ Tower	0.25	0.0275	-0.0353	0.0001	11.0	14.1

Table 3a - Dynamic Crack Meter Blast Results

Blast Number	Date	Gage ID	Location	Displacement (inches) Max Threshold	Peak Max	Peak Min	Offset[1]	% Max Threshold	% Min Threshold
10	5/25/2004 2:05	CM_0001	S Outlet Tunnel; 15+16 Wall	0.05	0.0008	-0.0011	0	1.6	2.2
	5/25/2004 2:05	CM_0002	S Outlet Tunnel; 15+40 Wall	0.05	0.0007	-0.0008	0	1.4	1.6
	5/25/2004 2:05	CM_0003	S Outlet Tunnel; 15+40 Ceiling	0.05	0.0009	-0.0009	0	1.8	1.8
	5/25/2004 2:05	CM_0004	S Outlet Tunnel; 15+50 Ceiling	0.05	0.0009	-0.0009	0	1.8	1.8
	5/25/2004 2:05	CM_0005	S Outlet Tunnel; 15+65 Wall	0.05	0.0008	-0.0007	0	1.6	1.4
	5/25/2004 2:05	CM_0006	S Outlet Tunnel; 15+68 Wall	0.05	0.0008	-0.0011	0	1.6	2.2
	5/25/2004 2:05	CM_0007	S Outlet Tunnel; 15+71 Ceiling	0.05	0.0008	-0.0009	0	1.6	1.8
	5/25/2004 2:05	CM_0008	S Outlet Tunnel; 15+86 Ceiling	0.05	0.0010	-0.0009	0.0001	2.0	1.8
	5/25/2004 2:05	CM_0009	S Outlet Tunnel; 15+86 Wall	0.05	0.0006	-0.0009	0	1.2	1.8
	5/25/2004 2:05	CM_0010	S Outlet Tunnel; 15+95 Ceiling	0.05	0.0009	-0.0009	0	1.8	1.8
	5/25/2004 2:05	CM_0011	S Outlet Tunnel; 15+98 Wall	0.05	0.0007	-0.0009	0	1.4	1.8
	5/25/2004 2:05	CM_0012	S Outlet Tunnel; 16+27 Wall	0.05	0.0009	-0.0009	0	1.8	1.8
	5/25/2004 2:05	CM_0013	N Outlet Tunnel; 15+48 Ceiling	0.05	0.0008	-0.0009	0	1.6	1.8
	5/25/2004 2:05	CM_0014	N Outlet Tunnel; 15+66 Ceiling	0.05	0.0008	-0.0009	0	1.6	1.8
	5/25/2004 2:05	CM_0015	Pier 3 Footing SW	0.05	0.0006	-0.0007	0	1.2	1.4
	5/25/2004 2:05	CM_0016	Pier 3 Footing SE	0.05	0.0008	-0.0009	0	1.6	1.8
	5/25/2004 2:05	CM_0017	Bridge Deck Elev 1230 @ Pier 3	0.25	0.0027	-0.0033	0	1.1	1.3
	5/25/2004 2:05	CM_0018	Bridge Deck Elev 1230 @ Tower	0.25	0.0020	-0.0035	0.0001	0.8	1.4
11	5/26/2004 2:05	CM_0001	S Outlet Tunnel; 15+16 Wall	0.05	0.0025	-0.0028	-0.0001	5.0	5.6
	5/26/2004 2:05	CM_0002	S Outlet Tunnel; 15+40 Wall	0.05	0.0020	-0.0013	0	4.0	2.6
	5/26/2004 2:05	CM_0003	S Outlet Tunnel; 15+40 Ceiling	0.05	0.0009	-0.0010	0	1.8	2.0
	5/26/2004 2:05	CM_0004	S Outlet Tunnel; 15+50 Ceiling	0.05	0.0012	-0.0014	0	2.4	2.8
	5/26/2004 2:05	CM_0005	S Outlet Tunnel; 15+65 Wall	0.05	0.0012	-0.0009	0	2.4	1.8
	5/26/2004 2:05	CM_0006	S Outlet Tunnel; 15+68 Wall	0.05	0.0016	-0.0017	-0.0001	3.2	3.4
	5/26/2004 2:05	CM_0007	S Outlet Tunnel; 15+71 Ceiling	0.05	0.0021	-0.0020	0	4.2	4.0
	5/26/2004 2:05	CM_0008	S Outlet Tunnel; 15+86 Ceiling	0.05	0.0017	-0.0022	0	3.4	4.4
	5/26/2004 2:05	CM_0009	S Outlet Tunnel; 15+86 Wall	0.05	0.0008	-0.0009	0	1.6	1.8
	5/26/2004 2:05	CM_0010	S Outlet Tunnel; 15+95 Ceiling	0.05	0.0020	-0.0034	-0.0003	4.0	6.8
	5/26/2004 2:05	CM_0011	S Outlet Tunnel; 15+98 Wall	0.05	0.0078	-0.0060	NA[2]	15.5	11.9
	5/26/2004 2:05	CM_0012	S Outlet Tunnel; 16+27 Wall	0.05	0.0022	-0.0028	-0.0003	4.4	5.6
	5/26/2004 2:05	CM_0013	N Outlet Tunnel; 15+48 Ceiling	0.05	0.0016	-0.0011	0	3.2	2.2
	5/26/2004 2:05	CM_0014	N Outlet Tunnel; 15+66 Ceiling	0.05	0.0016	-0.0017	-0.0001	3.2	3.4
	5/26/2004 2:05	CM_0015	Pier 3 Footing SW	0.05	0.0014	-0.0016	-0.0001	2.8	3.2
	5/26/2004 2:05	CM_0016	Pier 3 Footing SE	0.05	0.0030	-0.0032	0	6.0	6.4
	5/26/2004 2:05	CM_0017	Bridge Deck Elev 1230 @ Pier 3	0.25	0.0164	-0.0164	-0.0001	6.6	6.6
	5/26/2004 2:05	CM_0018	Bridge Deck Elev 1230 @ Tower	0.25	0.0950	-0.3299	0.0001	NA[3]	NA[3]

1. Offset is measurement of offset immediately before and after a blast event and is not cumulative.
2. The instrument went off line during part or all of the blast and information was lost.
3. CM_0018 malfunctioned during early blasts, was reset on 20 May and experienced problems in the 26 May blast.

Table 4. Summary of geophone dynamic data results.

Table 4. Summary of geophone dynamic data results.

						Peak Particle Velocity (in/sec)		
Blast Number	Date	Gage	Location	Orientation	Triggered?	Measured	Max Threshold	% of Threshold
1	5/6/2004 3:05	SM_1501	Pier 3 Footing	Vert	Yes	0.64	16	4.00
	5/6/2004 3:05	SM_1501	Pier 3 Footing	Long	Yes	0.73	16	4.56
	5/6/2004 3:05	SM_1501	Pier 3 Footing	Tran	Yes	0.55	16	3.44
	5/6/2004 3:05	SM_1601	Spillway	Vert	Yes	0.29	16	1.81
	5/6/2004 3:05	SM_1601	Spillway	Tran	Yes	0.56	16	3.50
	5/6/2004 3:05	SM_1601	Spillway	Long	Yes	0.37	16	2.31
2	5/11/2004 2:05	SM_1301	Gate Tower Elev 1112 ft	Vert	Yes	0.25	16	1.56
	5/11/2004 2:05	SM_1301	Gate Tower Elev 1112 ft	Tran	Yes	0.5	16	3.13
	5/11/2004 2:05	SM_1301	Gate Tower Elev 1112 ft	Long	Yes	0.45	16	2.81
	5/11/2004 2:05	SM_1302	Gate Tower Elev 1075 ft	Vert	Yes	0.15	16	0.94
	5/11/2004 2:05	SM_1302	Gate Tower Elev 1075 ft	Long	Yes	0.2	16	1.25
	5/11/2004 2:05	SM_1302	Gate Tower Elev 1075 ft	Tran	Yes	0.45	16	2.81
	5/11/2004 2:05	SM_1501	Pier 3 Footing	Long	No	0.48	16	3.00
	5/11/2004 2:05	SM_1501	Pier 3 Footing	Vert	No	0.22	16	1.38
	5/11/2004 2:05	SM_1501	Pier 3 Footing	Tran	No	0.46	16	2.88
	5/11/2004 2:05	SM_1601	Spillway	Vert	Yes	0.65	16	4.06
	5/11/2004 2:05	SM_1601	Spillway	Tran	Yes	0.83	16	5.19
	5/11/2004 2:05	SM_1601	Spillway	Long	Yes	0.84	16	5.25
	5/11/2004 2:05	SM_1701	Top of Gate Tower Elev 1228 ft	Vert	Yes	0.91	16	5.69
	5/11/2004 2:05	SM_1701	Top of Gate Tower Elev 1228 ft	Tran	Yes	0.63	16	3.94
	5/11/2004 2:05	SM_1701	Top of Gate Tower Elev 1228 ft	Long	Yes	0.95	16	5.94
3	5/12/2004 2:05	SM_1101	Trunnion support	Long	No	0.35	6	5.83
	5/12/2004 2:05	SM_1102	Tunnel Sta. 15+57, Elev. 1043.0	Long	No	0.2	16	1.25
	5/12/2004 2:05	SM_1103	Tunnel Sta. 15+82, Elev. 1041.0	Long	No	0.2	16	1.25
	5/12/2004 2:05	SM_1104	Tunnel Sta. 16+97, Elev. 1040.0	Long	No	0.1	16	0.63
	5/12/2004 2:05	SM_1301	Gate Tower Elev 1112 ft	Vert	Yes	0.25	16	1.56
	5/12/2004 2:05	SM_1301	Gate Tower Elev 1112 ft	Tran	Yes	0.5	16	3.13
	5/12/2004 2:05	SM_1301	Gate Tower Elev 1112 ft	Long	Yes	0.55	16	3.44
	5/12/2004 2:05	SM_1302	Gate Tower Elev 1075 ft	Vert	Yes	0.2	16	1.25
	5/12/2004 2:05	SM_1302	Gate Tower Elev 1075 ft	Tran	Yes	0.35	16	2.19
	5/12/2004 2:05	SM_1302	Gate Tower Elev 1075 ft	Long	Yes	0.15	16	0.94
	5/12/2004 2:05	SM_1501	Pier 3 Footing	Vert	No	0.26	16	1.63
	5/12/2004 2:05	SM_1501	Pier 3 Footing	Tran	No	0.45	16	2.81
	5/12/2004 2:05	SM_1501	Pier 3 Footing	Long	No	0.4	16	2.50
	5/12/2004 2:05	SM_1601	Spillway	Vert	Yes	0.43	16	2.69
	5/12/2004 2:05	SM_1601	Spillway	Tran	Yes	0.62	16	3.88
	5/12/2004 2:05	SM_1601	Spillway	Long	Yes	0.58	16	3.63
	5/12/2004 2:05	SM_1701	Top of Gate Tower Elev 1228 ft	Vert	Yes	0.69	16	4.31
	5/12/2004 2:05	SM_1701	Top of Gate Tower Elev 1228 ft	Long	Yes	0.91	16	5.69
	5/12/2004 2:05	SM_1701	Top of Gate Tower Elev 1228 ft	Tran	Yes	0.71	16	4.44

Table 4. Summary of geophone dynamic data results.

Blast Number	Date	Gage	Location	Orientation	Triggered?	Peak Particle Velocity (in/sec) Measured	Max Threshold	% of Threshold
4	5/13/2004 2:05	SM_1101	Trunnion support	Long	Yes	0.3	6	5.00
	5/13/2004 2:05	SM_1102	Tunnel Sta. 15+57, Elev. 1043.0	Long	Yes	0.25	16	1.56
	5/13/2004 2:05	SM_1103	Tunnel Sta. 15+82, Elev. 1041.0	Long	Yes	0.25	16	1.56
	5/13/2004 2:05	SM_1104	Tunnel Sta. 16+97, Elev. 1040.0	Long	Yes	0.05	16	0.31
	5/13/2004 2:05	SM_1501	Pier 3 Footing	Vert	No	0.24	16	1.50
	5/13/2004 2:05	SM_1501	Pier 3 Footing	Tran	No	0.32	16	2.00
	5/13/2004 2:05	SM_1501	Pier 3 Footing	Long	No	0.34	16	2.13
	5/13/2004 2:05	SM_1601	Spillway	Vert	No	0.27	16	1.69
	5/13/2004 2:05	SM_1601	Spillway	Tran	No	0.26	16	1.63
	5/13/2004 2:05	SM_1601	Spillway	Long	No	0.36	16	2.25
	5/13/2004 2:05	SM_1701	Top of Gate Tower Elev 1228 ft	Vert	Yes	0.86	16	5.38
	5/13/2004 2:05	SM_1701	Top of Gate Tower Elev 1228 ft	Tran	Yes	0.71	16	4.44
	5/13/2004 2:05	SM_1701	Top of Gate Tower Elev 1228 ft	Long	Yes	0.59	16	3.69
5	5/17/2004 1:05	SM_1101	Trunnion support	Long	Yes	0.3	6	5.00
	5/17/2004 1:05	SM_1102	Tunnel Sta. 15+57, Elev. 1043.0	Long	Yes	0.2	16	1.25
	5/17/2004 1:05	SM_1103	Tunnel Sta. 15+82, Elev. 1041.0	Long	Yes	0.25	16	1.56
	5/17/2004 1:05	SM_1104	Tunnel Sta. 16+97, Elev. 1040.0	Long	Yes	0.05	16	0.31
	5/17/2004 1:05	SM_1301	Gate Tower Elev 1112 ft	Vert	Yes	0.3	16	1.88
	5/17/2004 1:05	SM_1301	Gate Tower Elev 1112 ft	Long	Yes	0.55	16	3.44
	5/17/2004 1:05	SM_1301	Gate Tower Elev 1112 ft	Tran	Yes	0.45	16	2.81
	5/17/2004 1:05	SM_1302	Gate Tower Elev 1075 ft	Vert	Yes	0.2	16	1.25
	5/17/2004 1:05	SM_1302	Gate Tower Elev 1075 ft	Tran	Yes	0.4	16	2.50
	5/17/2004 1:05	SM_1302	Gate Tower Elev 1075 ft	Long	Yes	0.25	16	1.56
	5/17/2004 1:05	SM_1501	Pier 3 Footing	Vert	Yes	0.27	16	1.69
	5/17/2004 1:05	SM_1501	Pier 3 Footing	Tran	Yes	0.31	16	1.94
	5/17/2004 1:05	SM_1501	Pier 3 Footing	Long	Yes	0.34	16	2.13
	5/17/2004 1:05	SM_1601	Spillway	Vert	Yes	0.28	16	1.75
	5/17/2004 1:05	SM_1601	Spillway	Tran	Yes	0.22	16	1.38
	5/17/2004 1:05	SM_1601	Spillway	Long	Yes	0.49	16	3.06
	5/17/2004 1:05	SM_1701	Top of Gate Tower Elev 1228 ft	Vert	Yes	0.84	16	5.25
	5/17/2004 1:05	SM_1701	Top of Gate Tower Elev 1228 ft	Long	Yes	0.91	16	5.69
	5/17/2004 1:05	SM_1701	Top of Gate Tower Elev 1228 ft	Tran	Yes	0.61	16	3.81
6	5/18/2004 2:05	SM_1101	Trunnion support	Long	Yes	0.3	6	5.00
	5/18/2004 2:05	SM_1102	Tunnel Sta. 15+57, Elev. 1043.0	Long	Yes	0.35	16	2.19
	5/18/2004 2:05	SM_1103	Tunnel Sta. 15+82, Elev. 1041.0	Long	Yes	0.3	16	1.88
	5/18/2004 2:05	SM_1104	Tunnel Sta. 16+97, Elev. 1040.0	Long	Yes	0.05	16	0.31
	5/18/2004 2:05	SM_1301	Gate Tower Elev 1112 ft	Vert	Yes	0.3	16	1.88
	5/18/2004 2:05	SM_1301	Gate Tower Elev 1112 ft	Tran	Yes	0.5	16	3.13
	5/18/2004 2:05	SM_1301	Gate Tower Elev 1112 ft	Long	Yes	0.65	16	4.06
	5/18/2004 2:05	SM_1302	Gate Tower Elev 1075 ft	Vert	Yes	0.2	16	1.25
	5/18/2004 2:05	SM_1302	Gate Tower Elev 1075 ft	Tran	Yes	0.4	16	2.50
	5/18/2004 2:05	SM_1302	Gate Tower Elev 1075 ft	Long	Yes	0.3	16	1.88
	5/18/2004 2:05	SM_1501	Pier 3 Footing	Vert	No	0.28	16	1.75
	5/18/2004 2:05	SM_1501	Pier 3 Footing	Tran	No	0.39	16	2.44
	5/18/2004 2:05	SM_1501	Pier 3 Footing	Long	No	0.39	16	2.44
	5/18/2004 2:05	SM_1601	Spillway	Vert	Yes	0.38	16	2.38
	5/18/2004 2:05	SM_1601	Spillway	Tran	Yes	0.18	16	1.13
	5/18/2004 2:05	SM_1601	Spillway	Long	Yes	0.52	16	3.25
	5/18/2004 2:05	SM_1701	Top of Gate Tower Elev 1228 ft	Long	Yes	0.88	16	5.50
	5/18/2004 2:05	SM_1701	Top of Gate Tower Elev 1228 ft	Tran	Yes	0.6	16	3.75
	5/18/2004 2:05	SM_1701	Top of Gate Tower Elev 1228 ft	Vert	Yes	0.79	16	4.94

Table 4. Summary of geophone dynamic data results.

Blast Number	Date	Gage	Location	Orientation	Triggered?	Peak Particle Velocity (in/sec) Measured	Max Threshold	% of Threshold
7	5/19/2004 1:05	SM_1101	Trunnion support	Long	Yes	0.3	6	5.00
	5/19/2004 1:05	SM_1102	Tunnel Sta. 15+57, Elev. 1043.0	Long	Yes	0.3	16	1.88
	5/19/2004 1:05	SM_1103	Tunnel Sta. 15+82, Elev. 1041.0	Long	Yes	0.25	16	1.56
	5/19/2004 1:05	SM_1104	Tunnel Sta. 16+97, Elev. 1040.0	Long	Yes	0.05	16	0.31
	5/19/2004 1:05	SM_1301	Gate Tower Elev 1112 ft	Vert	Yes	0.45	16	2.81
	5/19/2004 1:05	SM_1301	Gate Tower Elev 1112 ft	Tran	Yes	0.55	16	3.44
	5/19/2004 1:05	SM_1301	Gate Tower Elev 1112 ft	Long	Yes	0.6	16	3.75
	5/19/2004 1:05	SM_1302	Gate Tower Elev 1075 ft	Vert	Yes	0.3	16	1.88
	5/19/2004 1:05	SM_1302	Gate Tower Elev 1075 ft	Long	Yes	0.3	16	1.88
	5/19/2004 1:05	SM_1302	Gate Tower Elev 1075 ft	Tran	Yes	0.4	16	2.50
	5/19/2004 1:05	SM_1501	Pier 3 Footing	Vert	No	0.26	16	1.63
	5/19/2004 1:05	SM_1501	Pier 3 Footing	Long	No	0.33	16	2.06
	5/19/2004 1:05	SM_1501	Pier 3 Footing	Tran	No	0.34	16	2.13
	5/19/2004 1:05	SM_1601	Spillway	Vert	No	0.16	16	1.00
	5/19/2004 1:05	SM_1601	Spillway	Tran	No	0.14	16	0.88
	5/19/2004 1:05	SM_1601	Spillway	Long	No	0.24	16	1.50
	5/19/2004 1:05	SM_1701	Top of Gate Tower Elev 1228 ft	Vert	Yes	1.39	16	8.69
	5/19/2004 1:05	SM_1701	Top of Gate Tower Elev 1228 ft	Tran	Yes	0.69	16	4.31
	5/19/2004 1:05	SM_1701	Top of Gate Tower Elev 1228 ft	Long	Yes	1.17	16	7.31
8	5/20/2004 2:05	SM_1101	Trunnion support	Long	Yes	0.25	6	4.17
	5/20/2004 2:05	SM_1102	Tunnel Sta. 15+57, Elev. 1043.0	Long	Yes	0.2	16	1.25
	5/20/2004 2:05	SM_1103	Tunnel Sta. 15+82, Elev. 1041.0	Long	Yes	0.2	16	1.25
	5/20/2004 2:05	SM_1104	Tunnel Sta. 16+97, Elev. 1040.0	Long	Yes	0.05	16	0.31
	5/20/2004 2:05	SM_1301	Gate Tower Elev 1112 ft	Vert	Yes	0.45	16	2.81
	5/20/2004 2:05	SM_1301	Gate Tower Elev 1112 ft	Tran	Yes	0.5	16	3.13
	5/20/2004 2:05	SM_1301	Gate Tower Elev 1112 ft	Long	Yes	0.7	16	4.38
	5/20/2004 2:05	SM_1302	Gate Tower Elev 1075 ft	Vert	Yes	0.45	16	2.81
	5/20/2004 2:05	SM_1302	Gate Tower Elev 1075 ft	Tran	Yes	0.35	16	2.19
	5/20/2004 2:05	SM_1302	Gate Tower Elev 1075 ft	Long	Yes	0.35	16	2.19
	5/20/2004 2:05	SM_1501	Pier 3 Footing	Vert	No	0.17	16	1.06
	5/20/2004 2:05	SM_1501	Pier 3 Footing	Tran	No	0.22	16	1.38
	5/20/2004 2:05	SM_1501	Pier 3 Footing	Long	No	0.2	16	1.25
	5/20/2004 2:05	SM_1601	Spillway	Vert	No	0.13	16	0.81
	5/20/2004 2:05	SM_1601	Spillway	Tran	No	0.13	16	0.81
	5/20/2004 2:05	SM_1601	Spillway	Long	No	0.23	16	1.44
	5/20/2004 2:05	SM_1701	Top of Gate Tower Elev 1228 ft	Vert	Yes	0.89	16	5.56
	5/20/2004 2:05	SM_1701	Top of Gate Tower Elev 1228 ft	Tran	Yes	0.72	16	4.50
	5/20/2004 2:05	SM_1701	Top of Gate Tower Elev 1228 ft	Long	Yes	0.76	16	4.75
9	5/21/2004 2:05	SM_1101	Trunnion support	Long	Yes	0.35	6	5.83
	5/21/2004 2:05	SM_1102	Tunnel Sta. 15+57, Elev. 1043.0	Long	Yes	0.3	16	1.88
	5/21/2004 2:05	SM_1103	Tunnel Sta. 15+82, Elev. 1041.0	Long	Yes	0.2	16	1.25
	5/21/2004 2:05	SM_1104	Tunnel Sta. 16+97, Elev. 1040.0	Long	Yes	0.05	16	0.31
	5/21/2004 2:05	SM_1301	Gate Tower Elev 1112 ft	Vert	Yes	0.35	16	2.19
	5/21/2004 2:05	SM_1301	Gate Tower Elev 1112 ft	Tran	Yes	0.4	16	2.50
	5/21/2004 2:05	SM_1301	Gate Tower Elev 1112 ft	Long	Yes	0.7	16	4.38
	5/21/2004 2:05	SM_1302	Gate Tower Elev 1075 ft	Vert	Yes	0.35	16	2.19
	5/21/2004 2:05	SM_1302	Gate Tower Elev 1075 ft	Tran	Yes	0.4	16	2.50
	5/21/2004 2:05	SM_1302	Gate Tower Elev 1075 ft	Long	Yes	0.35	16	2.19
	5/21/2004 2:05	SM_1501	Pier 3 Footing	Vert	No	0.16	16	1.00
	5/21/2004 2:05	SM_1501	Pier 3 Footing	Tran	No	0.17	16	1.06
	5/21/2004 2:05	SM_1501	Pier 3 Footing	Long	No	0.17	16	1.06
	5/21/2004 2:05	SM_1601	Spillway	Vert	No	0.11	16	0.69
	5/21/2004 2:05	SM_1601	Spillway	Tran	No	0.15	16	0.94
	5/21/2004 2:05	SM_1601	Spillway	Long	No	0.15	16	0.94
	5/21/2004 2:05	SM_1701	Top of Gate Tower Elev 1228 ft	Vert	Yes	0.56	16	3.50
	5/21/2004 2:05	SM_1701	Top of Gate Tower Elev 1228 ft	Tran	Yes	0.66	16	4.13

Table 4. Summary of geophone dynamic data results.

						Peak Particle Velocity (in/sec)		
Blast Number	**Date**	**Gage**	**Location**	**Orientation**	**Triggered?**	**Measured**	**Max Threshold**	**% of Threshold**
11	5/26/2004 2:05	SM_1101	Trunnion support	Long	Yes	0.25	6	4.17
	5/26/2004 2:05	SM_1102	Tunnel Sta. 15+57, Elev. 1043.0	Long	Yes	0.2	16	1.25
	5/26/2004 2:05	SM_1103	Tunnel Sta. 15+82, Elev. 1041.0	Long	Yes	0.2	16	1.25
	5/26/2004 2:05	SM_1104	Tunnel Sta. 16+97, Elev. 1040.0	Long	Yes	0.05	16	0.31
	5/26/2004 2:05	SM_1501	Pier 3 Footing	Long	No	0.34	16	2.13
	5/26/2004 2:05	SM_1501	Pier 3 Footing	Vert	No	0.22	16	1.38
	5/26/2004 2:05	SM_1501	Pier 3 Footing	Tran	No	0.44	16	2.75
	5/26/2004 2:05	SM_1601	Spillway	Long	Yes	0.35	16	2.19
	5/26/2004 2:05	SM_1601	Spillway	Tran	Yes	0.51	16	3.19
	5/26/2004 2:05	SM_1601	Spillway	Vert	Yes	0.26	16	1.63
	5/26/2004 2:05	SM_1701	Top of Gate Tower Elev 1228 ft	Long	Yes	0.78	16	4.88
	5/26/2004 2:05	SM_1701	Top of Gate Tower Elev 1228 ft	Vert	Yes	0.52	16	3.25
	5/26/2004 2:05	SM_1701	Top of Gate Tower Elev 1228 ft	Tran	Yes	0.55	16	3.44

Table 5. Summary of strain gage dynamic results.

Table 5 - Summary of strain gage dynamic data results.

Blast Number	Date	Gage ID	Location	Strain (μstrain) Max Threshold	Peak Max	Peak Min	Offset[1]	% Max Threshold	% Min Threshold
1	5/6/2004 3:05	SG_0003	SW Corner Intake; Elev 1131.4	100	0	0	0	0	0
	5/6/2004 3:05	SG_0004	SW Corner Intake; Elev 1105.0	100	3.6	-3.5	0.4	3.6	3.5
	5/6/2004 3:05	SG_0005	SW Corner Intake; Elev 1118.9	100	7.4	-3.7	-0.1	7.4	3.7
	5/6/2004 3:05	SG_0006	SW Corner Intake; Elev 1091.0	100	7.7	-3.2	2.3	7.7	3.2
2	5/11/2004 2:05	SG_0003	SW Corner Intake; Elev 1131.4	100	0	0	0	0	0
	5/11/2004 2:05	SG_0004	SW Corner Intake; Elev 1105.0	100	4.5	-5.4	-0.2	4.5	5.4
	5/11/2004 2:05	SG_0005	SW Corner Intake; Elev 1118.9	100	6.4	-5.2	0.1	6.4	5.2
	5/11/2004 2:05	SG_0006	SW Corner Intake; Elev 1091.0	100	5.1	-3.5	0.1	5.1	3.5
3	5/12/2004 2:05	SG_0003	SW Corner Intake; Elev 1131.4	100	0	0	0	0	0
	5/12/2004 2:05	SG_0004	SW Corner Intake; Elev 1105.0	100	8.4	-7.6	0.2	8.4	7.6
	5/12/2004 2:05	SG_0005	SW Corner Intake; Elev 1118.9	100	5.6	-4.9	0	5.6	4.9
	5/12/2004 2:05	SG_0006	SW Corner Intake; Elev 1091.0	100	4.1	-5	0.1	4.1	5
4	5/13/2004 2:05	SG_0003	SW Corner Intake; Elev 1131.4	100	0	0	0	NA[2]	NA[2]
	5/13/2004 2:05	SG_0004	SW Corner Intake; Elev 1105.0	100	7.1	-7.2	0.2	7.1	7.2
	5/13/2004 2:05	SG_0005	SW Corner Intake; Elev 1118.9	100	5.5	-4.5	-0.2	5.5	4.5
	5/13/2004 2:05	SG_0006	SW Corner Intake; Elev 1091.0	100	9.2	-2.2	2.1	9.2	2.2
5	5/17/2004 1:05	SG_0003	SW Corner Intake; Elev 1131.4	100	0	0	0	NA[2]	NA[2]
	5/17/2004 1:05	SG_0004	SW Corner Intake; Elev 1105.0	100	9.7	-8.5	0	9.7	8.5
	5/17/2004 1:05	SG_0005	SW Corner Intake; Elev 1118.9	100	4.5	-5.5	0	4.5	5.5
	5/17/2004 1:05	SG_0006	SW Corner Intake; Elev 1091.0	100	7.5	-5	-1.8	7.5	5
6	5/18/2004 2:05	SG_0003	SW Corner Intake; Elev 1131.4	100	0	0	0	NA[2]	NA[2]
	5/18/2004 2:05	SG_0004	SW Corner Intake; Elev 1105.0	100	12.6	-12.7	-0.3	12.6	12.7
	5/18/2004 2:05	SG_0005	SW Corner Intake; Elev 1118.9	100	8.7	-5.2	0	8.7	5.2
	5/18/2004 2:05	SG_0006	SW Corner Intake; Elev 1091.0	100	12.5	-4	2.3	12.5	4
7	5/19/2004 1:05	SG_0003	SW Corner Intake; Elev 1131.4	100	0	0	0	NA[2]	NA[2]
	5/19/2004 1:05	SG_0004	SW Corner Intake; Elev 1105.0	100	10.6	-7.6	-0.3	10.6	7.6
	5/19/2004 1:05	SG_0005	SW Corner Intake; Elev 1118.9	100	25.4	-8.4	-0.2	25.4	8.4
	5/19/2004 1:05	SG_0006	SW Corner Intake; Elev 1091.0	100	27.8	-6.3	0.1	27.8	6.3
8	5/20/2004 2:05	SG_0003	SW Corner Intake; Elev 1131.4	100	NA[2]	0	0	NA[2]	NA[2]
	5/20/2004 2:05	SG_0004	SW Corner Intake; Elev 1105.0	100	13.8	-12.7	0.1	13.8	12.7
	5/20/2004 2:05	SG_0005	SW Corner Intake; Elev 1118.9	100	13.6	-8	0.1	13.6	8
	5/20/2004 2:05	SG_0006	SW Corner Intake; Elev 1091.0	100	13	-5.3	1.7	13	5.3
9	5/21/2004 2:05	SG_0003	SW Corner Intake; Elev 1131.4	100	0	0	0	NA[2]	NA[2]
	5/21/2004 2:05	SG_0004	SW Corner Intake; Elev 1105.0	100	12.1	-10.5	-0.4	12.1	10.5
	5/21/2004 2:05	SG_0005	SW Corner Intake; Elev 1118.9	100	15.3	-6.9	-0.1	15.3	6.9
	5/21/2004 2:05	SG_0006	SW Corner Intake; Elev 1091.0	100	9.9	-4.9	-0.4	9.9	4.9
10	5/25/2004 2:05	SG_0003	SW Corner Intake; Elev 1131.4	100	2.8	-2.7	-0.1	NA[2]	NA[2]
	5/25/2004 2:05	SG_0004	SW Corner Intake; Elev 1105.0	100	2.5	-3.1	-0.1	2.5	3.1
	5/25/2004 2:05	SG_0005	SW Corner Intake; Elev 1118.9	100	2.9	-3.2	0.1	2.9	3.2
	5/25/2004 2:05	SG_0006	SW Corner Intake; Elev 1091.0	100	2.4	-2.8	-0.1	2.4	2.8
11	5/26/2004 2:05	SG_0003	SW Corner Intake; Elev 1131.4	100	2	NA[2]	NA[2]	NA[2]	NA[2]
	5/26/2004 2:05	SG_0004	SW Corner Intake; Elev 1105.0	100	7.2	-10.4	-2.2	7.2	10.4
	5/26/2004 2:05	SG_0005	SW Corner Intake; Elev 1118.9	100	9.2	-6.9	-0.2	9.2	6.9
	5/26/2004 2:05	SG_0006	SW Corner Intake; Elev 1091.0	100	4.3	-4.8	-0.1	4.3	4.8

1. Offset is measurement of offset immediately before and after a blast event and is not cumulative.
2. SG_0003 was inoperable during all blasting.